THz Photoconductive Antenna for 800 nm, Free Space Emitter and Receiver

PCA800

Description

This broad area interdigital photoconductive THz antenna is designed for ultrafast laser excitation wavelengths centered around 800 nm. The antenna can be used as terahertz emitter or detector in pulsed-laser, gated, broadband THz measurement systems for time-domain spectroscopy or as a photomixing emitter or detector in tunable, continuous-wave THz measurement systems in the frequency region from 0.1 to 3 THz.

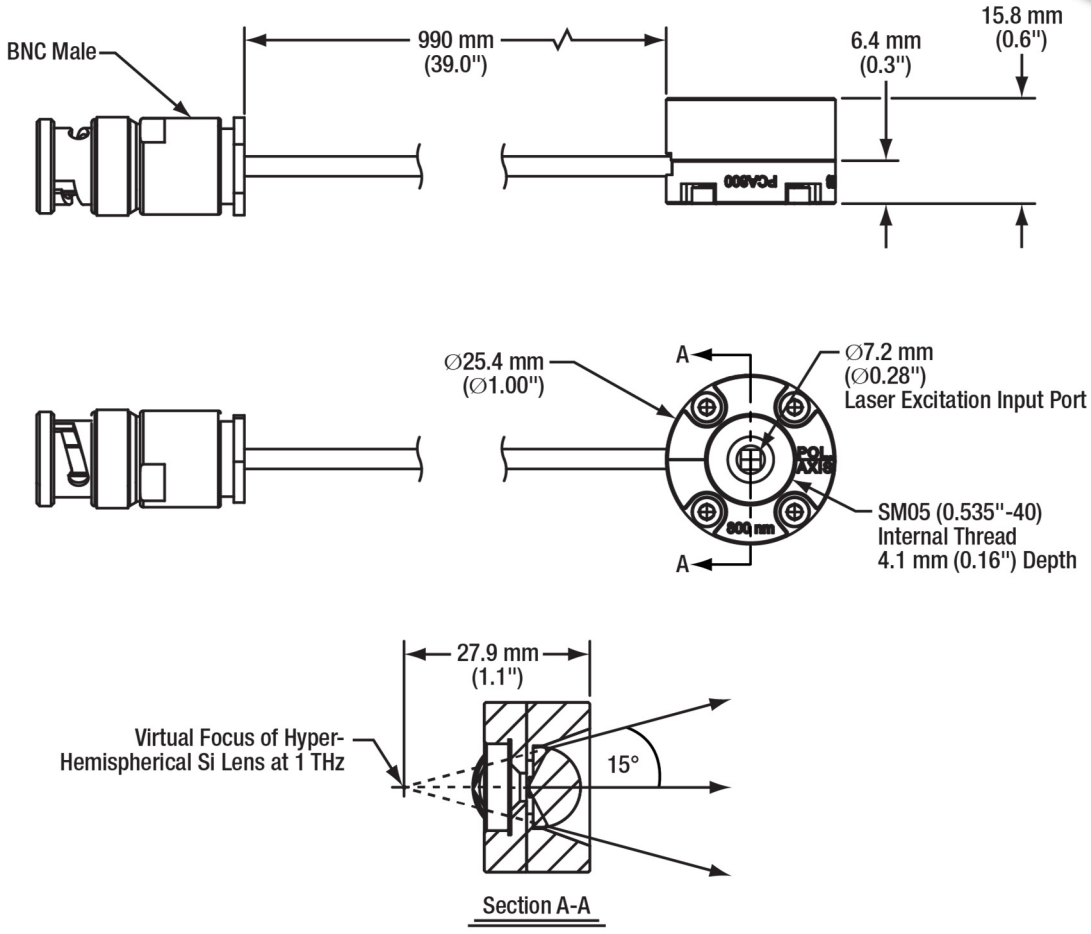
An HSL12 hyper-hemispherical silicon lens attached to the back of the antenna collects and directs the THz radiation into a diverging beam, which can be collimated using a THz collimating lens.

Specifications

PCA800	
THz Beam Divergence	15°
THz Beam Virtual Focal Length[a]	27.9 mm
THz Output Power[b]	<7 µW
Max Bias Voltage	±15 V
Bias Modulation Frequency	0 - 10 MHz
Excitation Laser Center Wavelength[c]	800 nm
Excitation Laser Polarization	Linear
Average Laser Power (P)[d]	<500 mW
Average Laser Intensity[d,e]	<620 W/cm^2
Laser Fluence[d]	<6 µJ/cm^2
Laser Beam Diameter (2*w_0)[f]	100 - 300 µm
Laser Pulse Duration[g]	<100 fs
Dark Resistance R_d[h]	>40 kΩ
Bias/Output Connector	BNC
Storage Temperature	-10 to 65 °C
Package Dimensions	Ø1" x 0.6" (Ø25.4 mm x 15.8 mm)

a. The virtual focal length is measured from the THz output of the antenna housing. Please see the drawing on the next page for details.
b. Max THz output saturates around 7 µW.
c. The acceptable wavelength range is from 650 nm to 850 nm.
d. Values higher than the maximum could cause damage to the antenna.
e. Average laser intensity is defined as $P/(\pi*w_0^2)$ for Gaussian beams.
f. $1/e^2$ Diameter
g. Pulse duration is taken at the antenna surface. Shorter pulse usually generates broader THz spectrum.
h. Measurement Conditions: Room Temperature and Measuring Voltage of 3.3 V

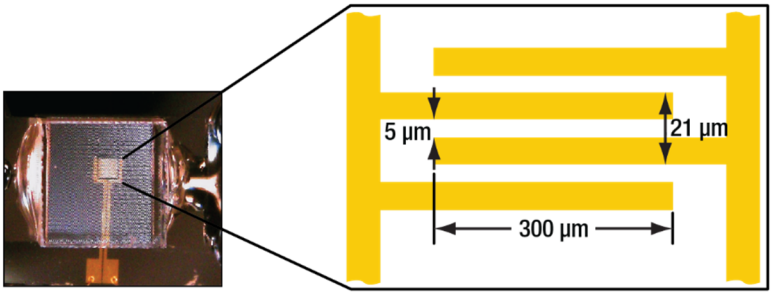
Drawings



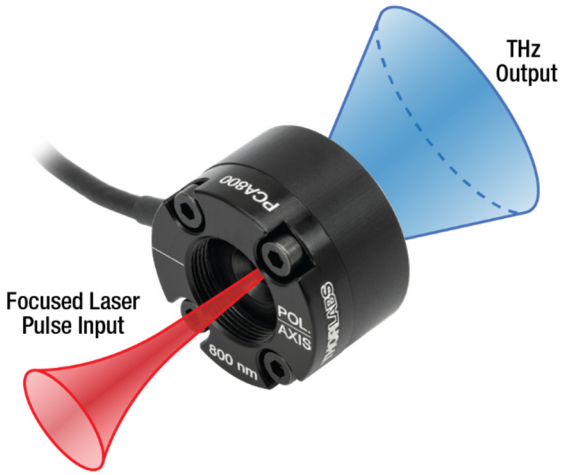
Antenna Design

PCA800	
THz Antenna Active Area[a]	300 x 300 µm
THz Antenna Dipole Length[a]	21 µm
THz Antenna Gap Distance[a]	5 µm
THz Antenna Chip Size	4 mm x 4 mm x 0.65 mm

a. See Antenna design diagram below. Please note that this diagram is not to scale, as indicated by the measurements.



Operation



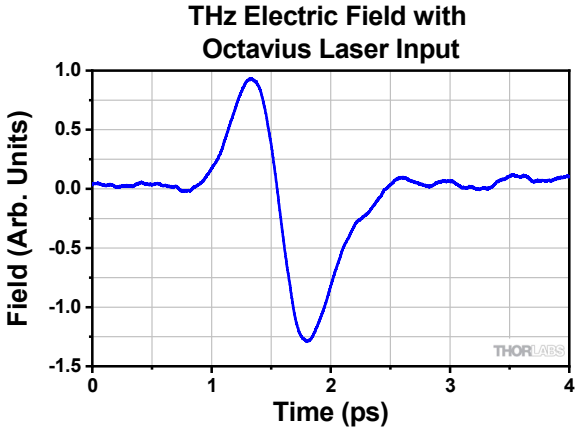
To use PCA800 as an emitter:

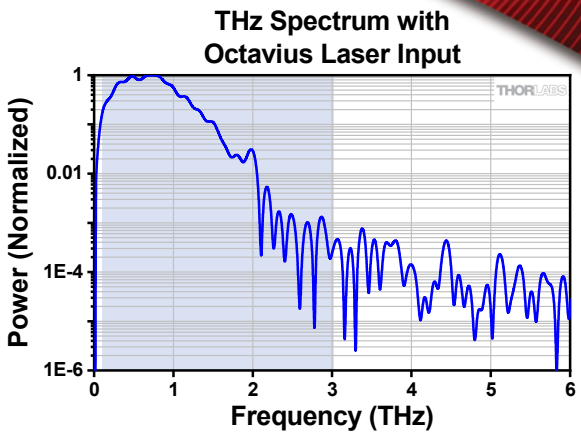
1. Calculate the optical intensity and energy at the antenna surface to be below the max values in the spec sheet.
2. Align the focused laser beam normal to the antenna surface. Note that the laser polarization needs to be linear relative to the marking on the antenna front side.
3. Further optimization can be made when the THz signal is found.
4. The antenna bias can be modulated, or a chopper can be used to modulate the laser for THz signal detection.

To use PCA800 as a detector:

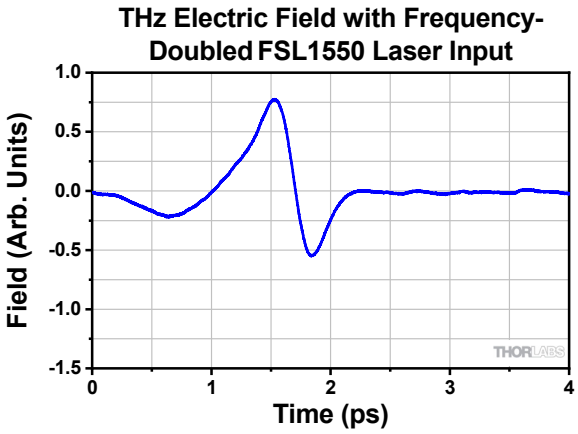
1. Calculate the optical intensity and energy at the antenna surface to be lower than that being used on the emitter.
2. Align the focused laser beam normal to the antenna surface. Further optimization can be made when the THz signal is found.
3. Adjust the delay between the THz pulse and the laser pulse so they coincide on the antenna. Note that 7.1 mm of HRFZ-Si lens behind the antenna with a refractive index of ~3.41 equals 24.2 mm optical path length in air, which has to be taken into account when calculating the delay between the two pulses.
4. The signal level is low, so a lock-in amplifier and averaging are recommended for data acquisition.

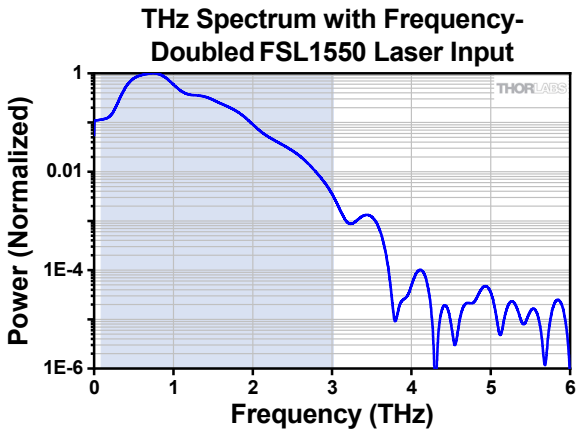
Performance Plots





For the data presented above, the input to the PCA800 Antenna had an average power of 300 mW with a 250 µm $1/e^2$ beam diameter from an OCTAVIUS-85M-HP Ti:Sapphire Laser. The spectrum was centered at 780 nm, and partially dispersion compensated to a 20 fs pulse duration. The antenna had a 15 V DC bias applied through the BNC connector, and the signal modulation frequency was 4 kHz.





For the data presented above, the input to the PCA800 Antenna was the second harmonic generation of an FSL1550 Femtosecond Fiber Laser. The frequency doubled output was centered at 775 nm, dispersion compensated to a transform limited 24 fs pulse duration, with an average power of 50 mW and a 250 µm $1/e^2$ beam diameter. The antenna had a 15 V DC bias applied through the BNC connector, and the signal modulation frequency was 4 kHz.